DLG Test Report 6511

Stela Laxhuber GmbH

Continuous flow dryer AgroDry MDB-XN 2/17-SB

Drying performance and energy demand

www.DLG Test.de

Overview

The DLG APPROVED quality mark on Individual Test Criteria is awarded to technical products that have passed a less comprehensive DLG usability test which is carried out and evaluated to independent and approved criteria. The purpose of the test is to highlight a product's specific innovations and key features. The test is carried out to criteria that are laid down in the 'DLG Full Test' framework for technical products or may include further features and properties that confer a specific value to the product.

STELA LAXHUBER
AGRODRY MDB-XN 2/17-SB
✔ **Drying performance**
✔ **Energy demand**
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A DLG group of experts defines the minimum standards to be applied to the product and describes the test conditions and procedures as well as the criteria by which the test results are to be evaluated. These parameters reflect the acknowledged state of the art as well as scientific findings and agricultural insights and requirements. After a product has passed the test, a test report is produced and published and the quality mark is awarded to the product and will retain its validity for five years from the date of award.

The DLG APPROVED test on "Dryers" verifies the quality and suitability of a specific dryer. The criteria 'drying performance and energy demand' determine the throughput of the dryer and the amount of energy it uses to produce this throughput. No other test criteria were applied to the product in this test.

Assessment – Brief Summary

In the test the continuous flow dryer achieved good results in terms of throughput and very good results in terms of its specific thermal energy demand.

It did not quite meet the throughput rate indicated by the manufacturer. This may be attributed to the fact that the bulk weight of the maize used in the test was significantly lower than the bulk weight the dryer is designed for.

Table 1:
Summary of results

Drying performance		Evaluation*
Throughput		
Dry crop (in operating conditions)	22.95 t/h	n.r.
Dry crop (in standard conditions)	21.05 t/h	○
Wet crop (in operating conditions)	29.39 t/h	n.r.
Wet crop (in standard conditions)	27.48 t/h	○
Moisture content drop in maize kernels	18.7 % (from 33.4 % to 14.7 %)	n.r.
Moisture extraction rate in maize kernels	6.43 t/h	n.r.
Energy demand		
Energy demand per tonne of wet crop		
– thermal energy	190.3 kWh/t	+ +
– electric energy	5.6 kWh/t	+ +
Specific energy demand per moisture extraction	750.8 kWh/t (2,703 kJ/kg)	+ +
Air throughput per tonne of wet crop	~7,300 m³	+ +

Comments
Standard conditions are defined as conditions in which the moisture content is reduced from 35 % to 15 % at 5 °C ambient temperature, 80 % relative humidity and 1,013 mbar pressure.
The measurements were taken at a hot air temperature of 132 °C and 135 °C. The design heat load is 125 °C.

* Evaluation range: ++ / + / ○ / – / – – (○ = standard, n.e. = not evaluated)

The Product

Manufacturer and Applicant

Stela Laxhuber GmbH, Laxhuberplatz 1, D-84323 Massing, Germany

Product: AgroDry® MDB-XN 2/17-SB continuous flow dryer

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Description and Technical Data

The AgroDry® MDB-XN 2/17-SB continuous flow dryer from Stela Laxhuber GmbH dries the crop as it flows from top to bottom within the two drying columns. The air enters and exits the grain heap through ducts that are shaped like inverted Vs. The warm intake air enters the heap through one duct, heating the grain and picking up excess moisture from it. The saturated and cooled air then exits the column through an outlet duct. The air is drawn through the drying columns by four fans.

The tested plant was specified with STELA-Biturbo technology which uses a mix of various airstreams – natural air which is drawn in from outside and heated by a linear burner as well as air that was preheated in the cooling zones. This mix is supplied to the bottom zone of the heap (bottom drying zone). The mixed flow is drawn by two axial fans and directed from the bottom drying zone to the top where hot natural air is added. This re-blended airstream is fed to the crop in the top drying zone by two axial fans and is exhausted after passing through the wet heap. The manufacturer claims that by controlling the air flow this way they can use the wet crop to clean the air and reduce the development of dust in the top drying zone. At the same time, this technology leads to a significant reduction of the amount of air required for the process.

Although the dryer was designed for maize, the manufacturer says it is also suitable for drying wheat and rapeseed.

Table 2:
Technical data (manufacturer information)

Produce information	
Produce	Maize*
Bulk weight (wet)	750 kg/m³
Feed moisture content	35 %
End moisture content	15 %
Design parameters	
Hot air temperature	130 °C
Ambient air temperature	10 °C
Humidity level	50 % relative humidity
Performance data	
Wet crop throughput	max. 33.6 t/h
Dry crop throughput	max. 25.7 t/h
Water evaporation rate	max. 7.9 t/h
Dryer specifications	
Volume	164 t**
Active volume	143 t**
Dimensions l x w x h	14.8 m x 7.8 m x 24.8 m
Connected wattage	184 kW

Fans		
Position	Exhaust fan	Intermediate fan
Number	2	2
Drive power per	55 kW	37 kW
Maximum air supply	2 x 98,500 m³/h	2 x 81,500 m³/h
Rated exhaust air flow	159,800 m³/h	
Air heater		
Model	Maxon linear burner	
Fuel	LP gas	
Caloric value	25-27 kWh/m³ in normal conditions	
Maximum wattage	2 x 5.4 MW	

Comments
* cleaned and naturally matured wet crop
** at 750 kg/m³ powder density

The Method

The test was carried out on a dryer that was installed on a farm situated in the Bydgoski district in Poland. The test was carried out on Nov 9 and 10, 2016. The farm fuels the dryer with propane gas and uses it to dry a wide range of different crops. This test assessed the plant's performance when drying maize.

Thanks to good weather conditions and the good timing of the test the grain maize was of a high quality.

To measure the dryer's performance, all batches of the wet maize were weighed on a gauged weigh-bridge in the course of the test. Furthermore, samples were taken from the wet and dry crop to determine the individual moisture levels.

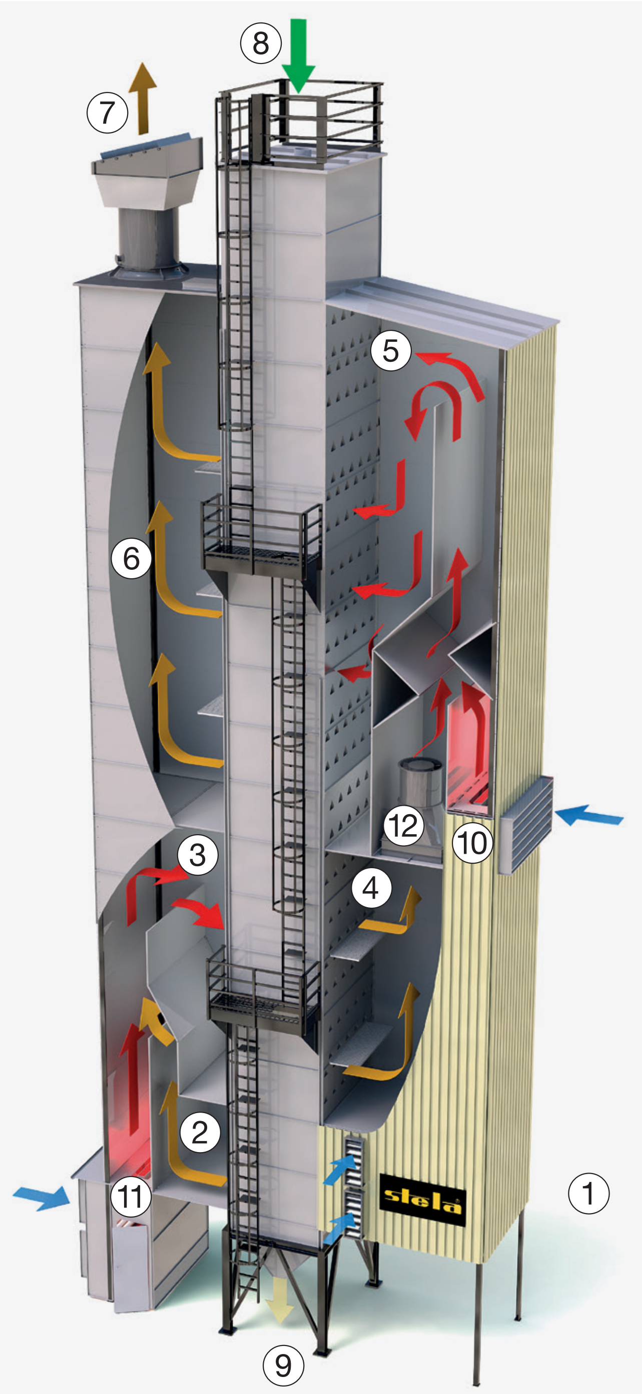

Figure 2:
Illustration of the dryer and its airflows.

The throughput of the wet crop ($\dot{m}_{FG}$) is calculated by dividing the weight of the wet crop (m_{FG}) by the time (t), taken for drying. See tables 1 and 2.

$$\dot{m}_{FG} = \frac{m_{FG}}{t}$$

The throughput of the dry crop ($\dot{m}_{TG}$) is arrived at by determining the throughput of the wet crop and the moisture levels of both the dry and wet crop (F_{TG} and F_{FG}).

$$\dot{m}_{TG} = \dot{m}_{FG} \times \frac{1 - F_{FG}}{1 - F_{TG}}$$

The drying performance data ($\dot{m}_{TG}$ and $\dot{m}_{FG}$) can then be used to determine the moisture extraction ($\dot{m}_{W}$):

$$\dot{m}_{W} = \dot{m}_{FG} - \dot{m}_{TG}$$

The demand of thermal energy was measured by gas counters.

The airstream rates were determined by measuring the pressure difference and establishing the relevant fan output curve.

Given the dryer's capacity of approx. 164 tonnes and an approx. 34 t/h throughput of dry maize, farmers typically have to 'budget' for a dead time of at least ten hours or two drying cycles before the system will settle in a stable operating point. According to the manufacturer, this dead time may vary depending on plant and weather conditions.

The performance data listed below were arrived at by converting the measurements to values that reflect standard conditions. The assessments started after the system had settled in a stable operating point. Each test cycle covered approx. 14 hours.

All test cycles are depicted in this test report.

The Test Results in Detail

Table 3 on page 6 shows the individual test results. The blue figures reflect measurements, all remaining data are arrived at by calculation.

Operation

The dryer is operated manually. It is not automatically controlled relative to the crop's current moisture content at input and/or output. Neither does it measure the moisture content of the incoming crop. Due to these facts it may be possible that the dryer is not operated at its full potential.

The design uses higher temperatures at the bottom than at the top. During the test, the intake air in the bottom drying zone reached about 150 °C which compares with a 130 °C temperature in the top drying zone and translates into a constantly 20 K lower temperature.

Throughput

Approx. 21.05 t of dry crop were put through the dryer every hour during which the moisture level dropped from 35 % to 15 % at an ambient temperature of 5°C. To maintain this throughput, 27.48 t of fresh maize had to be provided every hour.

This translates into an water extraction rate of 6.43 t/h. In the test, the plant did not quite meet the throughput level indicated by the manufacturer. This might be attributed to the actual bulk weight of the maize (680kg/m³), which was clearly lower than the bulk weight the dryer was designed for (750 kg/m²).

Energy demand

During the test the mean caloric value was 5,230 kW. This means that it takes 190.3 kWh of thermal energy to dry one tonne of fresh maize. With an average of 6.43 t of water evaporating every hour, it takes 2,703 kJ (the equivalent of 751 kWh/t) to evaporate one kilogramme of water.

Consequently, in 50 °C grain at an ambient pressure of 1,013 bar it takes theoretically 2,382 kJ to evaporate one kilogramme of water (approx. 1 litre).

Taking into account the efficiency of a convective dryer, these are very good figures.

The average demand of electric energy was 164.4 kW, which means that it takes 5.6 kWh of electric energy to dry one tonne of fresh crop. This is also a very good result.

Temperatures inside the dryer

Figure 3 shows the temperatures inside the dryer and how they vary within one test cycle lasting from 2 pm to 6 pm. As you can see, the temperature varies very little – a fact that is attributed to the stable operating point.

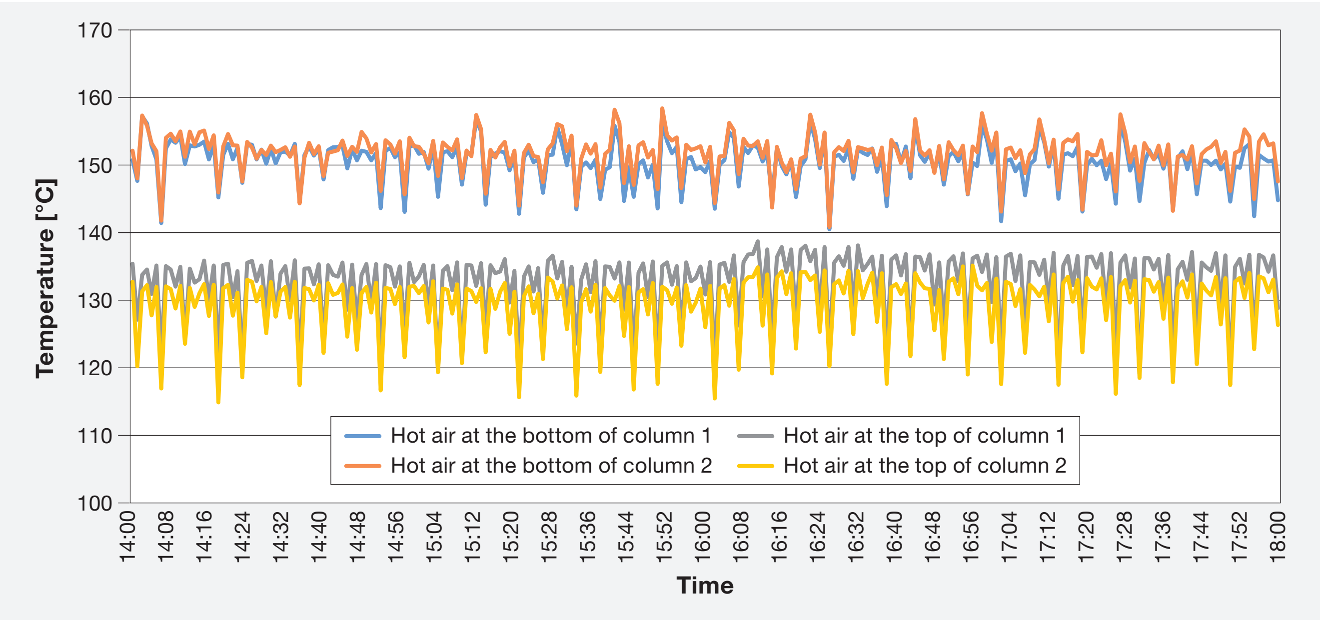

Figure 3:
Intake air temperatures inside the dryer [°C].

Table 3:
Measurements and calculations

	Ref. no. in figure 2	
Date		**9 to 10 November 2016**
Crop		**Maize**
Testing period		**10:17 to 00:12**
Total testing time		**13.92 hours**
Mass to be dried		
Total mass (dry crop)		319.43 t
Total mass (wet crop)		409.12 t
Ambient conditions		
Relative humidity	1	90.1 %
Ambient air temperature	1	-1.4 °C
Ambient pressure	1	1,000 mbar
Intake air temperatures		
Preheated air in col. 1	2	45.1 °C
Preheated air in col. 2	2	53.0 °C
Hot air at bottom of col. 1	3	150.9 °C
Hot air at bottom of col. 2	3	151.7 °C
Intermediate air mix in col. 1	4	61.3 °C
Intermediate air mix in col. 2	4	66.6 °C
Hot air at top of col. 1	4	132.5 °C
Hot air at top of col. 2	5	129.6 °C
Air conditions		
Rel. exhaust air humidity in col. 1	7	>95.0 %
Rel. exhaust air humidity in col. 2	7	91.9 %
Exhaust air temp. in col. 1	7	40.1 °C
Exhaust air temp. in col. 2	7	42.1 °C
Average maize moisture levels		
Wet crop moisture level	8	33.4 %
Dry crop moisture	9	14.7 %
Extracted moisture		18.7 %
Throughput		
Dry crop	9	22.95 t/h
Corrected to reflect standard conditions		21.05 t/h
Wet crop	8	29.39 t/h
Corrected to reflect standard conditions		27.48 t/h
Moisture extraction		
Related to standard conditions		6.43 t/h
Gas consumption (operating volume)		
Top burner	10	121.1 m³/h
Bottom burner	11	80.8 m³/h
Total		201.9 m³/h
Specific rate in dry crop		9.6 m³ gas/t
Specific rate in wet crop		7.3 m³ gas/t
Specific rate in wet crop		0.7 m³ LP gas/100 kg
Specific rate in wet crop		0.4 m³ LP gas/100 kg
Specific rate in wet crop		1.9 m³ of natural gas/100 kg
Specific rate in wet crop		1.0 m³ of natural gas/t %

	Ref. no. in figure 2	
Caloric output		
Top burner	10	3137.7 kW
Bottom burner	11	2091.8 kW
Total		5229.5 kW
Specific rate in dry crop		248.4 kWh/t
Specific rate in wet crop		190.3 kWh/t
Energy demand per unit of water		
In operating conditions		813.5 kWh/t
In operating conditions		2928.7 kJ/kg
Maize temperature correction		14.5 kJ/kg
Air temperature correction		-240.1 kJ/kg
Standard conditions (5 °C)		750.8 kWh/t
Standard conditions (5 °C)		2703.0 kJ/kg
Pressure difference		
Exhaust fan in col. 1	7	802 Pa
Exhaust fan in col. 2	7	724 Pa
Intermediate fan in col. 1	12	664 Pa
Intermediate fan in col. 2	12	706 Pa
Throughput		
Exhaust fans	7	200,000 m^3/h
Intermediate fans	12	165,000 m^3/h
Exhaust flow rate	7	200,000 m^3/h
Specific rate in dry crop		9,500 m^3/t
Specific rate in wet crop		7,278 m^3/t
Electric power		
Averaged results		164.4 kW
Av. result per 1t of wet crop		5.6 kWh/t

Comments
Standard conditions are defined as conditions in which the moisture content is reduced from 35 % to 15 % at 5 °C ambient temperature, 80 % relative humidity and 1,013 mbar pressure.

Summary

The results of the test show that the AgroDry® MDB-XN 2/17-SB continuous flow dryer from Stela Laxhuber GmbH meets the 'standard or better' (○) criteria in the 'drying performance and energy demand' test scheme. As such it meets the requirements for receiving the DLG APPROVED quality mark on Individual Test Criteria. This means that the dryer is basically suitable for drying maize.

More Information

Further tests on dryers can be downloaded from **www.dlg-test.de/trocknung**

Test performed by

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DLG test scope

DLG APPROVED Test on "Dryers"
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The DLG

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